particularly among the larger kinds, and offers various suggestions, both as to increasing the number of domesticated forms and the conservation of wild species in reservation-areas, such as the Yellowstone Park. Valuable as many of his proposals are, it is to be feared, in the present relation of natural science to bodies politic, that they are somewhat of an utopian character. It is not easy to maintain such areas under entirely natural conditions and free from interference, administrative or otherwise. To take a small instance: it is notorious that in the New Forest, perhaps our nearest approach to such an area, the insect-population has greatly diminished during the last thirty years, and many rare and retired species are on the point of extinction.

In the artistic, though somewhat unequal, illustrations, and the excellence of printing and paper, the book is worthy of high praise. W. F. H. B.

OUR BOOK SHELF.

A Geological Sketch Map of Africa South of the Zambesi. By E. P. T. Struben, F.R.G.S. (London: Edward Stanford, 1896.)

THE chief object of this new map, and accompanying pamphlet, of South Africa is to show that the Witwatersrand beds occur over a large portion of Africa south of the Zambesi. The band of dolomite, already described by Mr. Draper, is used by the author as a means of identifying the various scattered portions of sandstones, conglomerates, &c., occurring in South Africa, and which in many localities have proved to be auriferous. That the auriferous strata of the Rand occur outside the Transvaal is an established fact; but Mr. Struben hardly brings forward enough evidence to show that the sandstones, conglomerates and dolomites, recognised by him as identical with the Witwatersrand beds, are really all of one age.

The table of strata is very meagre in detail; the formations recognised being "Granite, Carboniferous beds, Sandstones, Shales and other stratified rocks, and Limestone." The formations are too much lumped together to be of much service, and there remains a doubt that the dolomite limestone mentioned by Mr. Struben is of various ages. A strip of crystalline limestone is represented near the coast north of the Umzimkulu River, and coloured similarly to the dolomite, but no mention is made of the cretaceous rocks of the east coast. There is no attempt made to show the relationship of the Rand beds to the Dwyka conglomerate, the Zwaartebergen quartzites, and the older rocks of the Cape. The metamorphic schists underlying the formations of South Africa are not mentioned. The relation of the Rand beds to the coal-bearing strata is also not clearly stated. In Natal the relationship is drawn as one of perfect conformity; but it is certain that in the Transvaal the coal-bearing rocks are unconformable to the Rand beds, and of much more recent date.

Mr. Struben's map, as showing the localities in which the minerals occur in South Africa, is valuable, but it does not approach in scientific value to Dunn's map of South Africa. The stratigraphy of South Africa is extremely complex, and a solution can only be arrived at by a survey, such as was commenced by Dunn, Griesbach and Stow.

Wayside and Woodland Blossoms. A Pocket Guide to British Wild Flowers for the Country Rambler. (Second Series.) By Edward Step, F.L.S. Pp. 170. (London: Frederick Warne and Co., 1896.)

WE are glad to know that the first volume published under the same title as this has met with the success it deserves, and we hope the present pocket-book will have a similar welcome extended to it. Four hundred species of flowering plants were described and illustrated in the first series, which Mr. Step now supplements with descriptions of 325 species, 130 being represented upon coloured plates, while 23 are shown in black and white. The plates render the identification of a plant a comparatively easy matter, and the clear descriptions of the plants are worthy accompaniments to them. Mr. Thiselton-Dyer should rejoice at the opportunity which the book affords every one to learn something about botany from "wayside and woodland." It will be remembered that as president of the botanical section of the British Association last year, he condemned the system of botanical teaching followed in many schools for examination purposes, and pleaded that the subject should be developed as an educational instrument. In the course of his address he said: "The modern university student of botany puts his elders to blush by his minute knowledge of some small point in vegetable histology. But he can tell you little of the contents of a country hedgerow; and if you put an unfamiliar plant in his hands, he is pretty much at a loss how to set about recognising its affinities." Mr. Step's book provides such students with the materials to make up their deficiencies; it is a book which will develop the observant faculties in young students of natural history, and one which will make more lovers of botany than all the examination syllabuses and text-book formulas yet devised.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Fine Shooting-Star; and Heights of Meteors in August and November 1895.

A REMARKABLY bright shooting-star was seen here on Saturday, June 13, at 10.59 p.m., under such favourable conditions of a clear sky and warm calm air on that evening, that it may possibly have happened that other notes were kept of its appearance, in the South of England, by astronomical observers. It was not a large-sized fireball, but in its course of about 30° it increased quickly from the brightness of a 1st mag. star to that of Sirius and of Jupiter, and just before its disappearance it shone with a short white flash as bright as Venus, which lit up the sky quite distinctly to about 20° or 30° from its final bright expansion. The head was white, free from sparks, and left along the greater portion of its course a yellow streak of light, of which a portion 8° or 10° in length was visible 10 seconds, while a shorter piece, 3° or 4° long at the end of that, where the bright flash occurred, growing white and misty by degrees, remained visible for 40 seconds. Duration of the flight about 2 seconds; from 230°, + 20° to 208°, − 4°; the patch of long-enduring streak extending about from 212°, ± 0°, to 209°, − 3°.

This track is directed from the head of *Andromeda;* and albeit the meteor greatly resembled a bright August Perseïd in appearance, of which shower first members have been traced as early as the beginning of July, proceeding from radiant-points in much lower R.A. than the chief centre of the system, yet the displacements of this meteor's course in time and in position from the main stream of the Perseïds are too considerable to allow an explanation of its appearance of that kind to be proposed as a probable conjecture. But there are no less than four ordinary radiant points, all active at this time, as Mr. Denning has informed me, in *Cygnus*, *Lacerta*, and *Honores Frederici*, in the "List of 918 Radiant-points" which he has published in the Astronomical Society's *Monthly Notices* (vol. 50, p. 410, May 1890), at distances back along the line of flight, of 55°, 70°, 80°, and 100°, from which its flight was directed accurately; and it is from the last of these slender meteor-sources (No. 174 in his List), at 354°, + 39°, about 5° south of ι, κ *Honorum*, a centre of swift, long-pathed, streak-leaving meteors in June and

July, with a fine Venus-like shooting-star just similar to this present meteor (its streak remaining visible 5 secs.), observed at Bristol on June 14, 1887, among them, that Mr. Denning considers it most probable that the real course of this bright meteor was directed. Its path and that of the just similar one observed at Bristol, prolonged backwards, intersect each other at 354°. + 36°, close to this well-marked shower-position; and if additional notes of the meteor have been obtained at other stations, it will be an interesting question to examine if they bear out this conclusion.

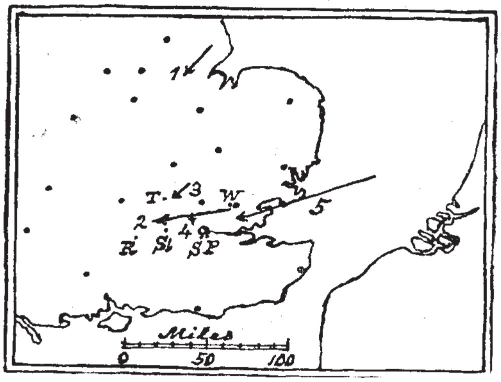
I take this opportunity of the returning abundance of meteors of the August period to beg to correct some errors of calculation and projection in my letter on "Heights of August Meteors" in NATURE of September 5, last year (vol. lii. p. 437), which gave confused descriptions, without, however, tripping (except slightly in the case of the second meteor) in the real values of the heights there found, of two meteors doubly observed at Tring and at Slough on August 11, 1895. The places over which the meteors were vertical when first seen, and at disappearance, were laid down in proper relation to Tring and Slough on a map of England, but from left to right instead of from right to left of the Tring and Slough meridian; so that although both their radiant-points were really easterly, their paths were described as from Oxfordshire to Middlesex, and from west to east across the northern part of Buckinghamshire, in my letter. The corrections applied to the observed paths of the second meteor were somewhat incorrectly chosen, and gave thereby resulting heights and a length of path which were somewhat faultily arrived at; while the radiant-point of this meteor (α Persei), given by the observations directly was a little departed from, and its altitude and azimuth were also given as 45°, 34° north of east, instead of 35°, 44° north of east. As uncertainties from errors inherent in meteor-observations (rarely very small ones) are unavoidable in comparing them together, a recalculation of both paths will, it seems probable, serve better to correct this maze of errors and mistakes, than to try to rectify individually the above principal ones, and a few lesser faults which the paths deduced last year contained.

Two other accordances, of a Perseïd shooting-star between Tring and Slough, and of a small fireball between Tring and Sydenham, in August last, and one of a rather notable fireball in November last, have afforded, since the path-descriptions in my former letter, some fairly good materials for height-determinations, although the data of the two fireballs' paths are of a little looser kind than those of the two foregoing and the one now newly-added shooting-stars. In the accompanying table I have grouped together what appear to be the real courses (including the two shooting stars' recalculated paths as Nos. 2, and 3, in the table), of all the meteors found here to have furnished accordant observations in last August and November; and I may add, in gladly expressed acknowledgment of the aid supplied abundantly by accuracy of the original observations to the general certainty of these determinations, that nearly all the present list of meteor-heights (only excepting those of the fireball of November 9) is due to some weeks' actively continued watch, with careful records of descriptions and well-mapped courses by the stars, successfully maintained at Writtle and at Tring by Mr. J. A. Hardcastle in order to obtain them, on the Perseïds and occasional meteor-members of other showers more or less conspicuous during the period of the display from Perseus, in August last.

In cases of loose, and of partially inconsistent descriptions, much latitude of choice is left to adjust the observed tracks to each other; but the limits of this choice become, in general, narrowly restricted if the ordinary descriptions and characters of meteor-flights are kept in view, and if any wholly improbable results, as of rising upwards, or of paths abnormally at variance with the usual heights, and not reconcilable with the acknowledged astronomical velocities of meteors, are rejected. The course of the fireball No. 5, of November 9, descending almost vertically in E.N.E. at each of the stations, Peckham, Slough, and Reading, where it was observed, along nearly the same apparent path (but beginning at those stations at nearly equal, and ending at very unequal altitudes), was situated so unfavourably for determining its radiant-point by the observed paths' mutual intersections, that only the ordinary conditions of meteor-flights (attained to here by trial and error combinations of more and more appropriate paths to satisfy them and the tolerably accordant observations also) could be usefully resorted to as the sufficient additional criterion needed to define the radiant-point, or the line of real direction of the meteor's course.

The observed paths at Writtle and at Slough of the Perseïd shooting-star, No. 1, are also in the unfavourable position of nearly "fore-and-aft" conjunction, but deviate sufficiently from it to yield the radiant-point noted in the list, by their mutual intersection, and from the heights, and meteor-speed given in the list, which are computed from it, this position of the point appears to stand in no further need of very material amendment by the proof test of the atmospheric and astronomical criterion.

In the case of the small fireball No. 4 (if the same meteor, as assumed from their resemblance, was really referred to in both the observations), besides a pretty large divergence from parallax direction between the two path-positions, making a rather considerable reconstruction of them both essential, a nearly lengthwise conjunction (as in Nos. 1, and 5) also once more occurs, introducing a large uncertainty, scarcely less than in the case of the fireball No. 5, into the position of the radiant-point, and into the consequent heights and length of path computed from it; which could only be overcome, as is done, it is to be hoped successfully, by the same tentative method of proceeding as that which was used to fix the real path and radiant of that latter fireball. With heights not far removed from sixty miles, and speeds not far from parabolic ones admitted, the construction's freedom becomes so greatly narrowed in these two fireballs' otherwise most equivocal-looking cases, that nearly as great, though (by unadjustable differences in the observations) still questionable dependence may be placed on these two fireballs' real paths and radiant-points as on those ascribed to the Perseïd and Piscid shooting-stars in the present list.



P, Peckham; R, Reading; S, Sydenham; Sl, Slough; T, Tring; W, Writtle.

The position thus found in *Gemini*, near *Castor*, of the radiant point of the fireball of November 9 last, perhaps affords a clue to the striking dark green light, not unlike the "signal green" colour of ships' lights and railway lamps, with which the fireball was seen to shine at Slough in the end-half of its course; since large-sized meteors of the "Geminid" shower diverging between the end of November and the middle of December from the immediate neighbourhood of the fireball's radiant-point position so determined, are notable for frequent occurrence of green hue in their nuclei. The low height of eight miles assigned to the meteor at its disappearance would nearly break record[1] of a fireball's deep penetration towards the earth before extinction, if the extraordinarily bright detonating fireball of December 14, 1890, had not been shown undoubtedly to have ended its shining course at not more than seven or eight miles above the earth, and that, too, by a curious coincidence, like the present meteor's end-point, over Billericay or some place close to Billericay, in Essex! Should observers in that latter county, or in any of the adjacent East Coast districts, have noted particulars of its appearance on November 9, which happened on a clear night during a prolonged display of a widely-observed and rather fine aurora (and, though the memory is a sad one to recall, especially on a date which was an annual one of rejoicing

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[1] The fireball which accompanied the fall of aërolites at Weston, Connecticut, in the United States, on December 14, 1807, was found by Dr. Bowditch to have remained luminous in its descent until only about three or four miles above the places on the earth's surface where the aërolites were scattered.

Table of observed Paths and Real Heights and Radiant Points of Meteors doubly observed in August and November 1895.

No.	Place; observer.	Date. 1895.	Hour. p.m.	Mag. by Stars, &c.	Colour.	Duration. Secs.	Length of path.	Apparent course and (do. corrected). From α δ To α δ
1	Writtle, Essex; J. A. Hardcastle. Slough, Bucks; A. S. Herschel.	Aug. 6 6	11.26 11.26	>1 >1	Blue White	Swift 0·7	10° (10) 6 (7)	170° + 70° 187½° + 62½° (162 + 72 186 + 63½) 97 + 68 117 + 71 (97 + 69 120 + 71)
2	Tring, Herts; J. A. H. Slough; A. S. H.	11 11	9.53 9.53	1; streak 1; streak 3 secs.	— White	2 or 3; slow 1·2	33° (35) 37 (35)	332½ + 39° 287½° + 42½° (327 + 41 279 + 40½) 331 + 53 268 + 51 (335 + 50 277 + 54)
3	Tring; J. A. H. Slough; A. S. H.	11 11	11.3 11.4	Streak 3	— —	— 0·6 ±	12° (16) 10 (9½)	345° + 58° 325° + 53° (337 + 57 315 + 49) 350 + 72 312 + 70 (359 + 71 324 + 71)
4	Tring; J. A. H. Sydenham.*	19 19	9.32 9.25 ±	>Vega Very bright star	Blue Blue, then red	2 ± 5 ±	22° (24) Almost stationary (4)	317½° + 37° 320° + 15° (310 + 42 322 + 18) ½ (Zen. ζ Urs. Maj.) 248 + 63 248 + 63 (273 + 65 262 + 66)
5	Reading; G. T. Davis. Peckham; H. Lawton. Slough; A. S. H.	Nov. 9 9 9	10.45 ± 10.40 ± 10.47	>3′ diameter; = ¼ ☽ Bright fire-ball 10 × ♀ ±	Orange-yellow — Orange, then green and red	3 ± — 2¾ or 3	12° in sight (17) 10 ± (11) 22 (17)	113° + 26° 120° + 15° towards β Cancri (further) to 122 + 10 (115 + 27 122½ + 11½) From a little left of α, β Gem. acr. ⅓ (β Gem., ♃) (112 + 34 120 + 23½) 113 + 31 119 + 9 (112½ + 30 118½ + 13½)

No.	Radiant-point (corrected) α δ and Az. Alt. and by nearest stars.	Real heights in miles at first appearance and disappearance.	Places vertically under the points of appearance, and disappearance.	Length of sloping path, in miles.	Observed speed; miles per second.	Parabolic speed; miles per second.
1	59° + 49° 42 E. fr. N. 34 λ Persei	72 59	½ (Spilsby and Kirkstead), Lincolnshire Near Gt. Ponton (by Grantham), Lincolnshire	29	42	39
2	23° + 9° 11 N. fr. E. 5 o Piscium	82 76	Colford, near Chelmsford, Essex Great Marlow, Bucks	53	44	41·5
3	48 + 50° 43 N. fr. E. 31 α Persei	53 43	Hitchin, Herts Near Berkhamstead, Herts	19·5	32 ±	40
4	286 + 62° 10 W. fr. N. 78 ½ (o, π) Draconis	60 26	½ (Barnet and Watford), Herts Sudbury, Middlesex	35	17	20
5	110° + 36° 19 N. fr. E. 34 α Gemin., 4° north	68 8	In the North Sea, 45 miles E. from Hollesley, Suffolk Billericay, Essex	107	39	39

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* The *English Mechanic*, August 23, 1895, vol. lii. p. 13.

in England and for the metropolis, only a few minutes before the occurrence of the terrible railway accident at Grantham on that night), I would be glad to know if they confirm the near approach to earth over the Brentwood Hills (as the end-point), and the position near Castor (as nearly the point of first appearance), assigned by this discussion to the meteor's flight; or if, as seen much sideways from its plane of fall, in counties north of Essex, the meteor's apparent line of flight may have been but little accordant perhaps, or even, quite possibly, not at all conformable with these sky-positions?

With regard to Mr. Denning's identification of the course of the above described bright meteor of the 13th inst., with a radiant-centre near *Honores*, I may mention in concluding that on the 19th inst., at 11.56, I noticed here a long-pathed streak leaving, 2nd mag. meteor shoot swiftly (about 30° in 1¼ sec.) from 195°, + 68°, in *Draco*, to 181°, + 39°, in *Canes Venatici*, leaving a thin white streak for 2½ seconds along its whole track. This course prolonged backwards about 60° proceeds from 350°, + 37°, only 3° or 4° from the place at 354°, + 39°, of the radiant No. 174 of Mr. Denning's list; and like the brighter shooting-star of June 13, it evidently belonged to this same June "Honorid" system. Mr. Denning's outline of the shower's duration, through the latter half of June and the first week of July, with a date of maximum on June 26, would thus seem, for this year's return of its meteor-period at least, to be in a fair way to be realised.

A. S. Herschel.

Observatory House, Slough, June 20.

Purification of Sulphur.

It is never a very pleasant or gracious task to reply to criticism. When that criticism, however, is based on a misapprehension of the facts, and is consequently wrong and misleading, and is, moreover, enforced by whatever weight "authority" may carry, its correction is simplified down to a plain matter of duty. The criticism to which I refer is contained in Prof. Armstrong's address to the Chemical Society (*Chem. Soc. Journ.*, vol. xxxix. p. 1160), which has just come before me.

The passage to which I refer runs as follows. "To return to sulphur, an abstract account has recently been published in the *Proceedings* of the Royal Society (1894, lvi. 32) of observations by Threlfall, Brearley and Allen, on the electrical properties of pure (*sic*) sulphur, *i.e.* sulphur from the Chance recovery process purified by distillation and exhaustion in vacuo. Such a process cannot be accepted by any means as an exhaustive one, and it appears almost to be a case of 'love's labour lost' to apply to such material the infinite care which the authors appear to have taken in making the electrical measurements. Yet they arrive at the important conclusion that so long as a single modification be dealt with, such sulphur does not conduct while solid. A mixture of two modifications, however, does; but in view of the possibility of changes taking place during the production of the mixture, of conducting impurities being introduced or generated, it is difficult to regard this latter conclusion as established; the more so as the authors in question have found that, as the temperature was raised the conductivity of the sulphur increased slightly up to the melting point, when there was an enormous increase."

Prof. Armstrong prefaced the paragraph which I have quoted above, by some rather ungenerous remarks as to the supposed attitude of physicists towards the question of chemical purification of material. It is now eight years since I began to endeavour to purify materials, so that I can, at all events, agree with Prof. Armstrong on one point, viz. that it is much more difficult to purify a substance up to the furthest limit of chemical discrimination, than it is to determine its physical properties afterwards. In the passage to which I now allude—and which I do not intend to quote, for I feel sure that Prof. Armstrong will, on consideration, agree with me that it is better forgotten—the "tongue of the scorner" is thrust out at those physicists who take no thought as to the condition of material examined by them. However true this may once have been, I am sure that nowadays it is a mere superstition to suppose that physicists, as a body, are callous on the subject of purification. A great deal of modern work in this domain of chemistry has been done by professed physicists; and indeed, though I have myself known several physicists enormously interested in questions of purification, I have only known one chemist whose life-long endeavour was to get things pure, and that was the late Prof. Josiah P. Cook, of Harvard. Passing to the immediate point, Prof. Armstrong objects to the use of the word "pure," made by myself and my co-workers. With regard to this, I may say that Prof. Armstrong labours under the disadvantage of only having an abstract under his notice. In the paper (if it ever gets published) he will find that this very matter is discussed at, perhaps, too great a length, and the conclusion arrived at that the word "pure" ought to be kept for substances in such a degree of purity that existing chemical or physical means fail in discovering any foreign substance. "Pure," therefore, as we have used the word, has no meaning except in connection with the existing state of the art of chemistry, and was adopted by us rather than the word "purified," as the result of some consideration, in which a desire to avoid pedantry had some weight. Since Prof. Armstrong refers eulogistically to Stas—as who would not—I may perhaps refer him to the following passages by Stas himself (*Bulletin de l'Académie Royale des Sciences, &c., de Belgique.* 2 séries, vol. x. p. 253), than whom no one could be more careful as to the use he makes of the word "pure."

"Jusqu'ici, il n'y a que M. Dumas qui ait tenté de faire la synthèse du sulfuré d'argent. Pour déterminer le rapport proportionnel de ses éléments, il a sulfuré directement l'argent par *du soufre pur* qu'il faisait passer en excès." . . . "En suivant cette méthode, j'ai fait deux séries d'expériences: la première, comprenant trois synthèses par *du soufre pur* amené en excès." Stas gives no details as to the preparation of his "soufre pur" (which he would certainly have done had elaborate precautions been taken); and as a matter of fact, Stas' sulphur was probably far less pure than mine, for in those days there was no "Chance" sulphur. So much for the word "pure."

Prof. Armstrong considers that the process of purification employed by us is "by no means an exhaustive one," &c. A process is, we take it, exhaustive when it exhausts the resources of physics, including chemistry. Now, we spent four years in trying all likely and many unlikely methods of purification. We finally, by sheer good fortune, received some Chance sulphur, and our methods of discrimination at once revealed to us that, when dust and water were removed, it was purer than any we had been able to prepare hitherto by the most elaborate means; and we adopted it as our source of sulphur in consequence of this discovery. On the other hand, there are doubtless degrees in the purity attained by the commercial product. The first lot we received (a present from Mr. Chance) was much purer than some afterwards purchased; and with this later sample the process we employed for purification would probably not have been sufficient.

With regard to the question of the adequacy of the purification—for this is the important point—we arrived at a stage at which no chemical means enabled us to detect any impurity whatever, and the specific resistance (if one may so misuse the term for a body which does not obey Ohm's law) rose above 10^{28} C.G.S. units; our limit of discrimination, and probably the furthest hitherto *certainly* attained.

As we had found that the purer the sulphur the better it insulated, as with this sulphur we could absolutely find no impurity at all, and as all our means of purification (except by repetition) were exhausted, we felt that we had done all that could possibly be done.

The conclusion at which we arrived—viz. that so-called mixtures of crystalline and amorphous sulphur conduct, whereas pure crystalline sulphur does not—seems to us to be of considerable importance, and we therefore spared no pains to assure ourselves of its truth. For this purpose we prepared crystalline sulphur films, ascertained their property by non-conductivity, and then converted them into the conducting mixture by appropriate heating and cooling. Conversely, we caused conducting "mixtures" to become non-conducting by annealing. Prof. Armstrong's criticism, therefore, is wrong, and the uncertainty, which he assumes, does not exist. It is as certain that crystalline sulphur is at least about a million times more non-conducting than "mixed" sulphur, as that copper conducts better than glass. We spent some years in assuring ourselves of the truth of this proposition, and we feel that we should be shirking our philosophical duty were we to allow this conclusion, so laboriously reached, to be set aside, or rendered nugatory, by a criticism based on a misapprehension, and enforced by all the weight which Prof. Armstrong's utterances so rightly carry.

I confess I am unable to reply to that part of Prof. Armstrong's criticism in which the above conclusion is supposed to